SIXTY YEARS OF *VOLUCELLA ZONARIA* (PODA) (DIPTERA: SYRPHIDAE) IN BRITAIN

ROGER K. A. MORRIS[1] AND STUART G. BALL[2]

[1]*7 Vine Street, Stamford, Lincs. PE9 1QE*
[2]*255 Eastfield Road, Peterborough PE1 4BH*

ABSTRACT

The history of the hoverfly *Volucella zonaria* in Britain is reviewed. It shows that there was evidence of range expansion long before recorders were alert to such changes. Possible factors behind its expansion of range are examined and it is shown that the distribution maps closely fit those parts of England with the mildest winter temperatures and highest summer temperatures. Readers are alerted to the possibility that populations are reinforced by influxes from the Continent and that detailed recording of this species and known migrants might help to shed further light on this aspect of its biology.

INTRODUCTION

Volucella zonaria (Poda) is one of the largest and most readily identifiable of British flies. Its size alone marks it out as distinct, whilst its vivid chestnut and gold markings make it noteworthy as a hornet mimic. Thus, it is a species that can be recorded accurately by even the most casual natural historian. The only species with which it can be confused is *Volucella inanis* (L), which is smaller and yellower and has a yellow rather than black second sternite. Although it is more widespread, *V. inanis* occupies a similar range.

The arrival of *V. zonaria* in the 1940s was heralded by much interest in the popular entomological press. For a period of ten years, it featured regularly in notes and observations and was even reported in the national press. These reports, together with numerous museum specimens, provide the foundation for our knowledge of its arrival and establishment.

When compiling the provisional atlas of British hoverflies, we suggested that *V. zonaria* might be gradually spreading from the London suburbs into the wider countryside (Ball & Morris, 2000). As a relatively recent arrival from the Continent, *V. zonaria* is a potentially useful subject for monitoring as part of studies following the changes in invertebrate populations in response to climate change. This note tests the hypothesis that its distribution is expanding. It describes the establishment and spread of *V. zonaria* and evaluates its current status based on available data.

EARLY PUBLISHED HISTORY

Until the 1940s, *V. zonaria* was very rarely recorded (Fig. 1a) and, according to Goffe's analysis (1945), was represented by just six confirmed British specimens; although Hobby (1946) reported a further two old records. At that time it would seem that *V. zonaria* was a rare vagrant and it was treated as such in the annual migration reports until the 1950s (Danreuther, 1946, 1952). Goffe, however, also drew on records from Folkestone, Bournemouth and Bristol in the 1940s and suggested that breeding populations may have been established. Fraser (1945) reinforced this conjecture with a report of "at least 8 specimens... seen or captured in Bournemouth" in 1945. Further evidence of the establishment of a population at

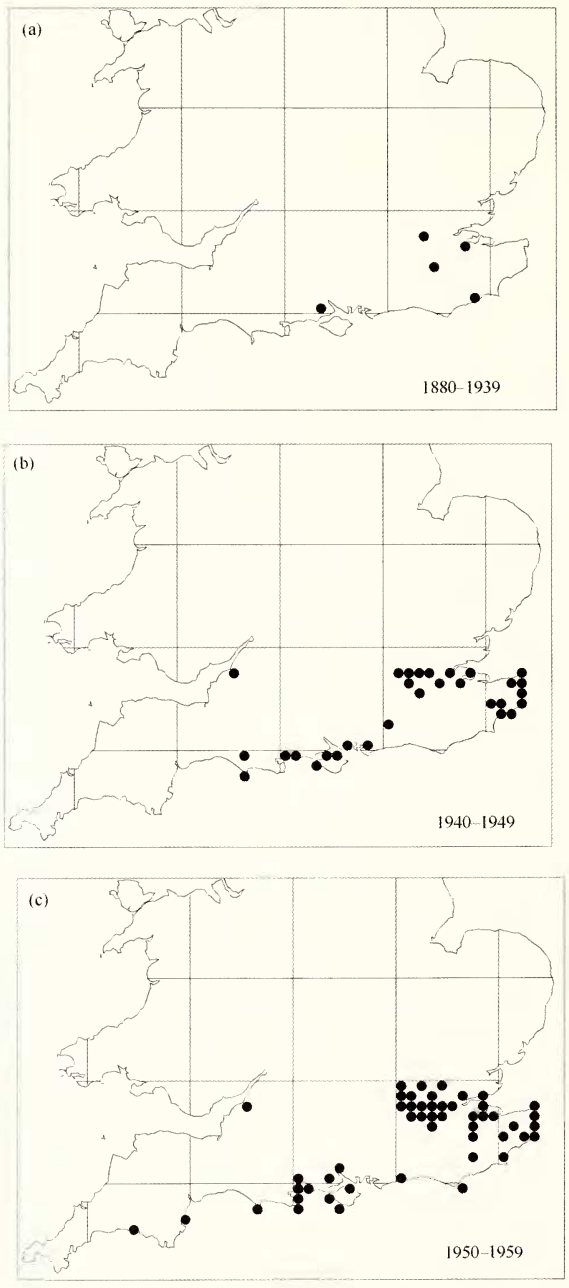

Fig. 1. Distribution of *Volucella zonaria* in Southern England, (a) 1880–1939, (b) 1940–1949, and (c) 1950–1959.

Folkestone was provided by Waller (1946) who reported the capture of five females and observations of a further 15+ specimens at ivy in September 1945. A report of regular records of *V. zonaria* from the Chatham area from 1938 onwards by Woodcock (1946) further reinforced the argument that *V. zonaria* had become established. This sequence of reports provides compelling evidence that there were established populations at a number of locations by 1945 and there is a strong probability of a population in the Chatham area perhaps as early as 1938.

The Bournemouth site provided the first evidence of a confirmed breeding population with a report by Fraser (1946a) of seventeen dipterous larvae recovered from the nest of the common wasp *Vespula vulgaris* (L.) in November 1945. Fraser subsequently reported (1946b) that he had bred out three *V. zonaria* and three *Volucella pellucens* (L.), and that on the basis of the proportions of the puparia, the overall ratio was eleven *V. zonaria* to six *V. pellucens*.

It is clear from the published literature that *V. zonaria* rapidly spread along the south coast e.g. Blair (1946) and O'Farrell (1946). The available evidence suggests that *V. zonaria* became established in south London soon after its initial arrival on the south coast. There is a published record for 27 August 1945 (Riley, 1946); but in his report to the South London Entomological and Natural History Society (SLENHS) on 28 August 1946, Riley fails to mention a capture the previous year. His account for the SLENHS reports the capture of this fly on 27 August 1946 (same date, different year) and that another had been taken two days previously by J.E.C. Riley-Irving (also Riley-Irving, 1947). However, Riley's 1945 record remains a conundrum because a report by Gardiner (1991) of *V. zonaria* on Wimbledon Common in 1945 supports the interpretation that this species was present there that year.

Between 1946 and 1960, the literature records and museum specimens showed that *V. zonaria* became widely established along the south coast as far as Torquay and Plymouth, and along the Kentish coast to London. Interestingly, the isolated population in the Bristol area is not linked to any obvious pattern of dispersal, but seems to have become established separately and has shown little evidence of further dispersal over subsequent years.

Interpretation of available data

We have identified over 1050 records, including specimens held in the Natural History Museum London and published accounts in the majority of relevant national journals. The data are not wholly complete, however, as we have not secured records from other major collections and regional collections.

There are two important sub-divisions within the data. Prior to the mid-1970s there was no co-ordinated means of collecting data, and we are largely left to the information available in the published literature. Between 1945 and 1955, there was a regular stream of new published records that tailed off towards the 1960s as *V. zonaria* became less noteworthy. The majority of museum specimens stem from this period and it is possible to locate many of the specimens reported at the time. From the mid-1970s, the Hoverfly Recording Scheme became an important focus for collecting data and around this time the published record largely dries up. However, the greatest emphasis on data collection by this scheme lies in the mid-1980s and again in the early 1990s.

Thus, the fluctuating fortunes of data collection are a factor that must be considered when evaluating apparent changes in the distribution and frequency of *V. zonaria*. A further factor that needs to be borne in mind is the inevitable problem of recorder bias arising from the recruitment and loss of active recorders over a

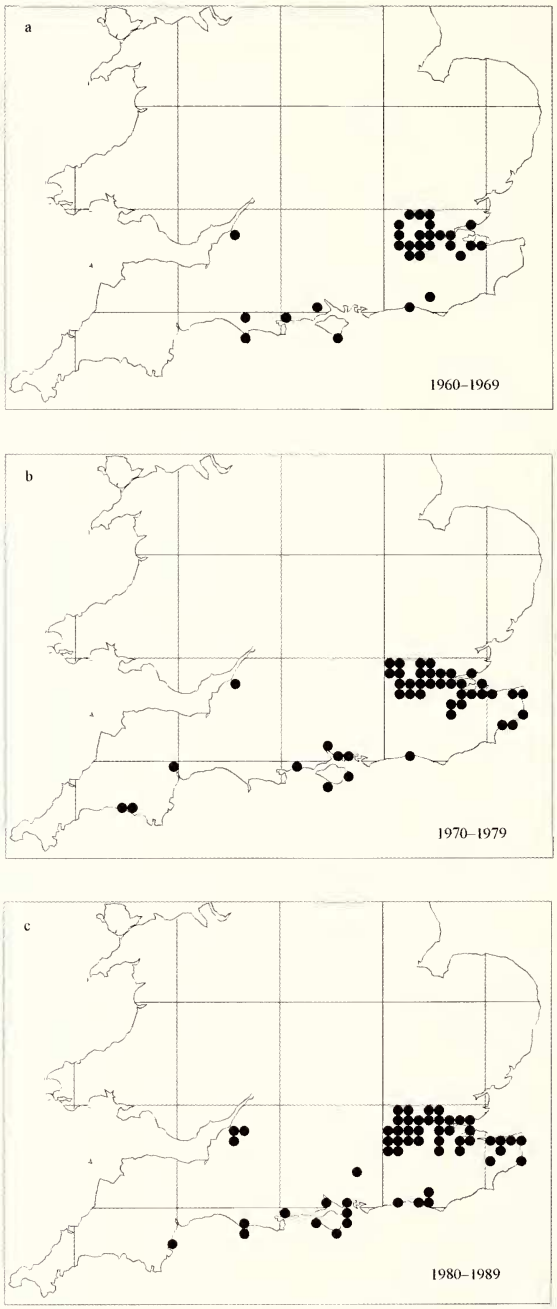

Fig. 2. Distribution of *Volucella zonaria* in Southern England, (a) 1960–1969, (b) 1970–1979, and (c) 1980–1989.

period spanning two or even three generations. Despite these difficulties, the data are robust enough to present a picture of the establishment and spread of *V. zonaria*, and to identify a number of key events over the past sixty years.

Distribution history

The changes in the distribution of *V. zonaria* are clearly demonstrated by the maps for the decades 1940 to 1949 and consecutively to 1979 (Figs 1–3). These maps show that between 1940 and 1959 the population seems to have expanded and consolidated along the south coast, the London suburbs and the Thames Estuary. This process appears to have halted in the 1960s before undergoing renewed expansion in the 1970s and 1980s.

A significant event in the 1960s was the extreme winter of 1962/1963 and it seems likely that this substantially reduced the population of *V. zonaria* except in the most sheltered situations. Unfortunately the 1960s coincided with a decline in interest in publishing records of *V. zonaria* and this hypothesis is hard to prove. Moreover, some observers report regular sightings in the London area from the 1960s onwards e.g. Wurzell (1980), suggesting that this was a period of under-recording. However, the records for the summers of 1976 and 1977, which were exceptionally hot, indicate that the fortunes of *V. zonaria* are highly dependent upon high summer temperatures. As the data show (Fig. 4), reported numbers peaked in 1977, consistent with reports of high numbers in Kent in 1977 by Dicker (1977), and of high numbers reported from the Tottenham area of London in 1976 by Wurzell (1980). The evidence therefore suggests that during the 1970s and 1980s, *V. zonaria* maintained relatively low but constant population levels with occasional noteworthy peaks following hot years and warm winters, slowly recovering from the 1960s population crash.

The 1990s have been established as a period of unprecedented warm temperatures (Bealey *et al.*, 1998) with a significant departure from previous temperature variations and a reduction in rainfall for much of the decade. During this period, *V. zonaria* has shown further signs of range expansion and indications that numbers have been increasing. Notably, its range extended westwards to Cornwall, northwards into Hertfordshire and eastwards towards the Suffolk borders. There is also a remarkable record of a specimen from Cambridge in 1991 (Gardiner, 1991) that was perhaps a harbinger of things to come. However, the numbers of records have not increased proportionately and Fig. 3b suggests that the Kentish population may have declined. This reinforces a similar observation by Clemons (1998): although some caution must be attached to this latter interpretation because his data also suggest that there was more recorder activity in Kent in the 1980s.

Between 2000 and 2001 two of the most remarkable records emerged, with a record from Sherringham in Norfolk (Paston, 2001) and from East Gloucestershire (D. Illif, pers.com.). These two records suggest that *V. zonaria* has moved considerably, but at the moment it is not possible to be sure that these specimens represent range expansion or primary migrants. The population at Harwich, which has been known since 1992, seems to coincide with a period of substantial activity amongst migratory insects as reported by Dr Chris Gibson (pers. comm.) "1991: one seen at Beacon Hill, Harwich, (TM262317), on a sunny day with much evidence of insect migration (lots of *Episyrphus*, Red Admirals, and a single Swallowtail butterfly); sunning itself on bramble leaves next to the promenade".

There is also an illuminating note by R. S. George (1991) which reported two specimens of *V. zonaria* brought for identification by Mrs Herbert-Graham from

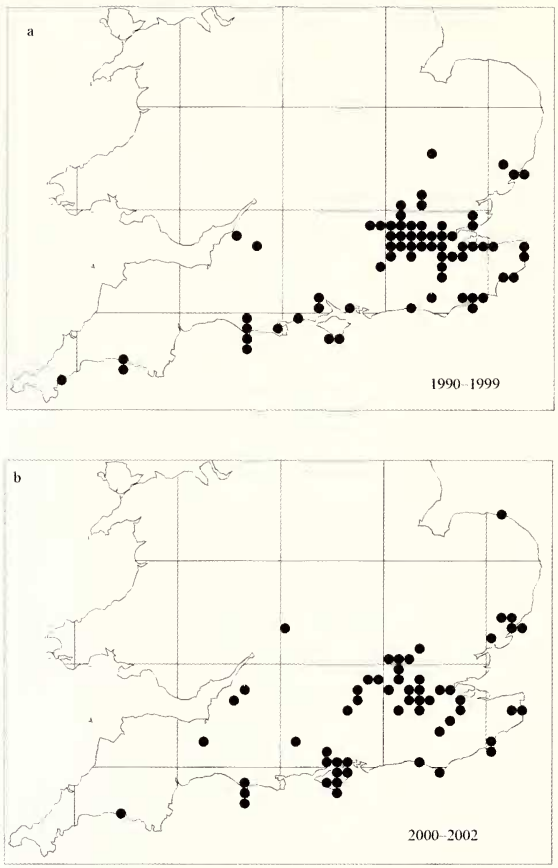

Fig. 3. Distribution of *Volucella zonaria* in Southern England and Wales, (a) 1990–1999, (b) 2000–2002.

Christchurch (Hants) because of concern that they might be hornets. These were seemingly part of a population of "scores, possibly hundreds, over a couple of days in early August" preceding an immense influx of syrphids later in the month. These accounts possibly lend support to the observation by Chandler (1969) that populations in the early years might have been supplemented by further influxes. It is possible that this remains a factor in the occurrence of *V. zonaria* and may explain the remarkable record from Cambridge in 1991, which could be coincident with the Christchurch observations (dates are not published).

In Surrey, one of the better-studied counties, *V. zonaria* showed few signs of spreading beyond the London suburbs after its establishment in the 1940s. Some westward movement along the Thames corridor is evident between 1970 and 1989, but apart from a record at Wisley, there are few indications of movement outside the urban environment (Fig. 2c). In the 1990s, however, a number of noteworthy records beyond the suburbs were reported. In addition to a further record from Wisley,

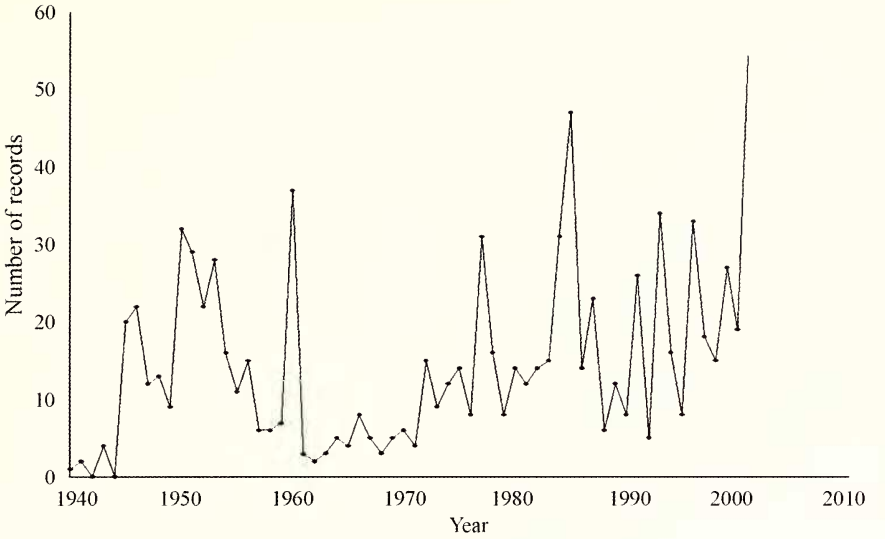

Fig. 4. Numbers of records of *Volucella zonaria*, 1940 to 2001.

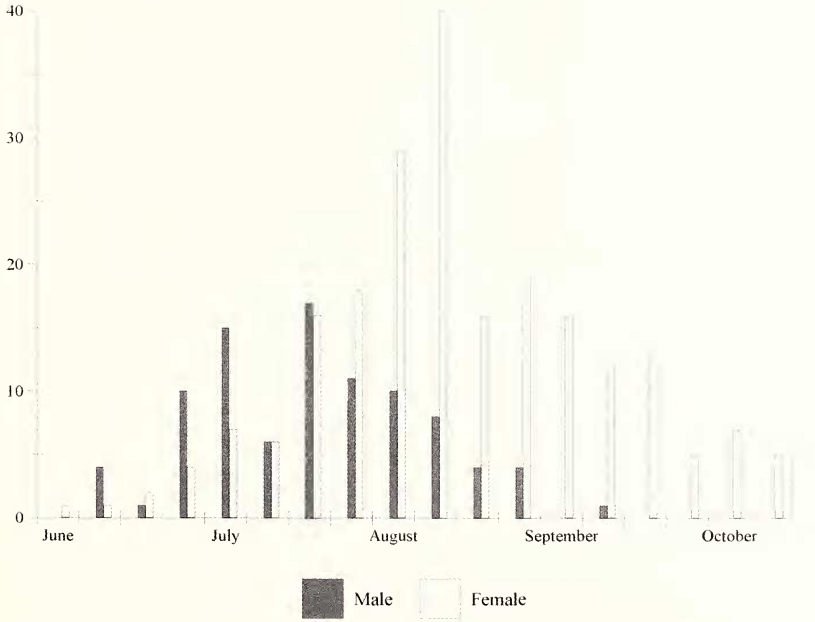

Fig. 5. Phenology of male and female *Volucella zonaria*.

indications of expanding distribution arise from reports of *V. zonaria* becoming increasingly frequent in the Woking area (Halstead, 2000) and clear evidence of a population in the Esher/Leatherhead area. Records from Gatton Park in central Surrey and from Elstead in south-west Surrey provide further indications of population movement to the south of London. Of course, this evidence is not conclusive but Surrey is a very comprehensively surveyed county. Records from the Box Hill area and Esher in 2001 provide further indications of an expansion of range.

Volucella zonaria is a continental species that is widely distributed and abundant in southern Europe. In England it is largely confined to the south coast, urban London and the Bristol area. Clearly there are fundamental controlling influences and we have investigated these further. The most likely factor, as we have already highlighted, is climate. Coastal areas are milder than inland and much less prone to frosts because of the proximity of the sea and its influence on adjacent land temperatures. Likewise, climate maps show that large urban areas such as London exhibit elevated temperatures in the summer and are less prone to frosts in winter. This is the so-called 'heat island effect' that leads to city centre temperatures being as much as 7 °C higher than surrounding countryside (USEPA, 1992).

We have found that comparison between the current distribution of *V. zonaria* with climate maps yields important and very close fits with temperature records. The climate maps shown in Plate 14 (Figs 6a and 6b) are based on work by New, Hulme and Jones (1999) and depict the distribution of average minimum January and maximum July temperatures between 1960 and 1990. Superimposition of areas where average minimum January temperatures remain at or above 1 °C with areas that experience average maximum July temperatures of 20.5 °C or above (Plate14, Fig. 6b) show remarkably close correlation with the distribution of *V. zonaria* (Fig. 7). These climate characteristics are more typical of southern European conditions. Thus, we believe that the future distribution of *V. zonaria* might be anticipated according to predictions of climate change that may lead to a more Mediterranean climate in southern England. Moreover, there is scope to predict where *V. zonaria* might occur in future. There are strong possibilities of a consolidation of range along the Suffolk and Norfolk coast, and movement through the Vale of Evesham perhaps as far as Birmingham: we therefore hope that recorders will maintain a vigilant watch for the appearance of *V. zonaria* in new areas.

Larval biology

Apart from *V. inflata* (Fabricius), the British *Volucella* are known to be associated with the nests of social bees and wasps. The published literature indicates that *V. zonaria* is solely associated with *Vespula vulgaris* nests, although Stubbs & Falk (2002) suggest that there is also an association with *Vespula germanica* (Fabricius), another ground-nesting species.

In his investigation of *Volucella* larvae in a *V. vulgaris* nest in Bournemouth, Fraser (1946b) secured eleven *V. zonaria* larvae. Else (1975) reports rearing more than a dozen *V. zonaria* from another *V. vulgaris* nest and there is a series of 17 specimens in the Natural History Museum (NHML), apparently from the same wasps' nest. He also reports the probability that adults emerge overnight. Apart from these two published records, we have found no other confirmed rearing records apart from one by Steven Falk in the Hoverfly Recording Scheme database and a puparium in the NHML collections from a wasps' nest in a roof.

From the limited information we have on rearing *V. zonaria*, it is apparent that wasp nests can support remarkable numbers of larvae, but it is clear that much more

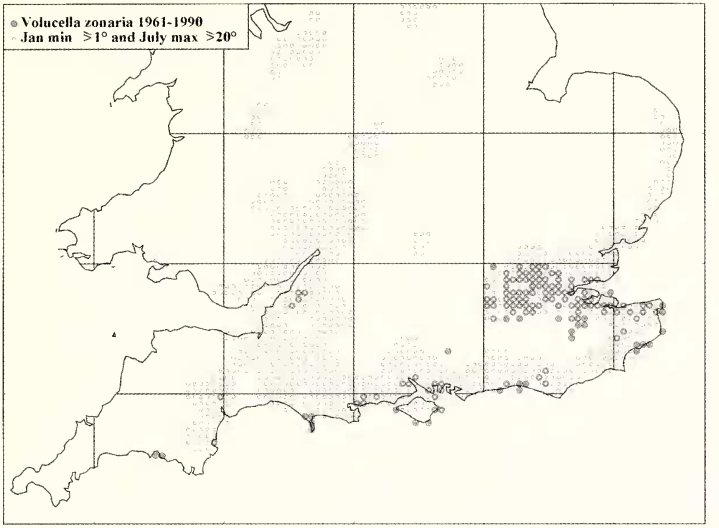

Fig. 7. Coincidence between occurrence of *Volucella zonaria* 1960–1990 in relation to January average minimum temperatures and July average maximum temperatures.

work is needed to understand its biology within the wasps' nest. Furthermore, rearing records do not support any presumed association with the hornet *Vespa crabro* Bequaert in England. Given the obligate association with social wasps and possibly only ground-nesting social wasps, the breeding success of *V. zonaria* is dependent on their breeding success. Anecdotally, it would seem that populations of social wasps, apart from the recent arrivals *Dolichovespula media* (Retzius) and *D. saxonica* (Fabricius) have experienced a number of unsuccessful years. This has important implications for *V. zonaria* and other related species [*V. inanis*, *V. pellucens* and *V. bombylans* (L.)]. At the moment, however, there would appear to be no reliable method of monitoring social wasp population fluctuations, without which it is difficult to investigate the relationship between the abundance of *V. zonaria* and the breeding success of its hosts.

Other biological information

The history of *V. zonaria* in Britain over the past sixty years suggests that its numbers fluctuate very considerably, as demonstrated in Fig. 4, which illustrates variations in the numbers of records on a yearly basis. This is supported by a number of reports by observers who have noted unusual peaks in numbers, among whom, Chandler (1969) who drew attention to these fluctuations and suggested the possibility of population reinforcement from time to time by further influxes from the continent.

The overall phenology of *V. zonaria* between 1940 and 2001 shows numbers increasing steadily from early June to peak in the first half of August before declining in September and October. As might be expected, males seemingly emerge earlier than females (Fig. 5) peaking in the middle of July compared with the second week of August for females. Many observations have reported a strong bias between male

and female *V. zonaria*, with females substantially outnumbering males. From the data we hold this disparity is very apparent. Of the records with detailed information on the sex of the specimen, the ratio of males to females is 1:3.

Despite the plethora of published notes, it is remarkable how few report flower visits. Even so, the following list indicates that *V. zonaria* will visit a very wide range of flowers: Ivy, Buddleja, Hebe, Privet and Scabious figure most strongly. The list comprises:

Clematis vitalba L., *Rubus fruticosus* L. agg., *Rosa canina* L., *Hedera helix* L., *Angelica sylvestris* L., *Heracleum sphondylium* L., *Foeniculum vulgare* Miller, *Stachys* spp., *Mentha* spp., *Mentha aquatica* L., *Mentha spicata* L., *Buddleja davidii* Franchet, *Hebe* spp., *Ligustrum* spp., *Sambucus nigra* L., *Symphoricarpos albus* (L.), *Succisa pratensis* Moench, *Cirsium vulgare* (Savi) Ten., *Cirsium arvense* (L.) Scop., *Centaurea nigra* L., *Solidago virgaurea* L., *Aster novii-belgii* L., *Achillea millefolium* L., *Eupatorium cannabinum* L., *Mesembryanthemum*, *Sedum spectabile* Boreau, *Phlox*, *Hydrangea*, *Allium* spp. (cultivated onion), *Allium porrum* L.

Summary and conclusions

The data held by the Hoverfly Recording Scheme have been used to investigate the changing range of *V. zonaria*. They offer conclusive evidence that this hoverfly is undergoing a period of expansion away from its traditional strongholds in the London suburbs, on the south coast and in the suburbs of Bristol. This expansion is likely to arise from movement within the native population, but there is circumstantial evidence of new immigrants reinforcing the population and perhaps being responsible for the establishment of some outlying coastal populations. It has also been demonstrated that there is strong correlation between the distribution of *V. zonaria* and both winter and summer temperatures that approximate to more southerly European conditions.

Our literature search and data review also show that there are very few examples of rearing *V. zonaria* larvae from social wasp nests in the UK and that at the moment very little is known about the relationship between *V. zonaria* and social wasps. Perhaps recorders will be stimulated to collect the detritus from wasp nests in the autumn and to rear out hoverfly larvae (please try to secure adult wasps too, so that the species involved can be identified). In this way we may get a clearer picture of the specific associations between *V. zonaria* and ground nesting or arboreal Vespidae.

Detailed recording and evaluation of yearly fluctuations may help to cast light on the state of resident populations and reinforcement from the Continent. We would be especially pleased to receive full details of the daily occurrence of this fly from garden monitoring projects and hope to produce further updates as appropriate information arises.

Acknowledgements

This note would not have been possible without the help of the many recorders who have contributed to the Hoverfly Recording Scheme. In particular we would like to thank Dr Chris Gibson for his detailed comments on *V. zonaria* in the Harwich area. We would also like to thank Nigel Wyatt of the Natural History Museum of London for access to the collections, and the Librarians of the NHML for access to the diaries of the late Len Parmenter.

References

Ball, S. G. & Morris, R. K. A. 2000. *Provisional atlas of British hoverflies*. Centre for Ecology and Hydrology, Abbott's Ripton.

Bealey, C., Howells, O. & Parr, T. 1998. Environmental change and its effects on wildlife: the role of the environmental change network. *British Wildlife* **9**: 341–347.

Blair, K. G. 1946. *Volucella zonaria* and other Syrphidae (Dipt.) in the Isle of Wight. *Entomologist's Monthly Magazine* **81**: 212.

Chandler, P. J. 1969. The Hoverflies of Kent (Diptera, Aschiza–Syrphidae and Pipunculidae). *Transactions of the Kent Field Club* **3**: 139–202.

Clemons, L. 1998. Further notes on the genus *Volucella* (Diptera: Syrphidae) in Kent. *Bulletin of the Kent Field Club* **43**: 77–84.

Dannreuther, T. 1946. Migration Records, 1945. *The Entomologist* **79**: 97–110.

Dannreuther, T. 1952. Migration Records. *The Entomologist* **85**: 155–160.

Dicker, G. H. L. 1977. *Volucella zonaria* (Poda) (Dipt., Syrphidae): unusually common in Kent. *Entomologist's Monthly Magazine* **113**: 192.

Else, G. R. 1975. An additional British breeding record of *Volucella zonaria* Poda (Dipt., Syrphidae) and two records of the species at Mercury Vapour lamps. *Entomologist's Monthly Magazine* **111**: 184.

Fraser, F. C. 1945. *Volucella zonaria* (Poda) (Diptera, Syrphidae) in Bournemouth. *Entomologist's Monthly Magazine* **81**: 237–238.

Fraser, F. C. 1946a. *Volucella* (Diptera, Syrphidae) larvae sp., breeding in a nest of *Vespula vulgaris* L. (Hym. Vespidae). *Entomologist's Monthly Magazine* **82**: 55–57.

Fraser, F. C. 1946b. A final report on the breeding of *Volucella* (Dipt., Syrphidae) larvae in a nest of *Vespula vulgaris* L. (Hym. Vespidae). *Entomologist's Monthly Magazine* **82**: 158–159.

Gardiner, B. O. C. 1991. *Volucella zonaria* in Cambridge. *Bulletin of the Amateur Entomologists' Society* **50**: 285.

George, R. S. 1991. *Volucella zonaria* (Poda) in Christchurch. *Bulletin of the Amateur Entomologists' Society* **50**: 287.

Goffe, E. R. 1945. *Volucella zonaria* (Poda, 1761) (Diptera, Syrphidae) in Britain. *Entomologist's Monthly Magazine* **81**: 159–160.

Halstead, A. J. 2000. Exhibit of Diptera: BENHS Annual Exhibition 27 November 1999. *British Journal of Entomology and Natural History* **13**: 168.

Hobby, B. M. 1946. What is the present status of *Volucella zonaria* Poda in Britain? *Proceedings of the Royal Entomological Society of London* **1946**(A): 21.

New, M., Hulme, M. & Jones, P. D. 1999. Representing twentieth century space–time climate variability. Part 1: development of a 1960–1990 mean monthly terrestrial climatology. *Journal of Climate* **12**: 829–856.

O'Farrell, A. F. 1946. *Volucella zonaria* (Poda) (Dipt., Syrphidae) in Sussex. *Entomologist's Monthly Magazine* **81**: 57.

Paston, S. 2001. Observations of the hoverfly *Volucella inanis* in west Norwich. *The Norfolk Natterjack* **75**: 2. Bulletin of the Norfolk & Norwich Naturalists' Society.

Riley, J. A. 1946. *Volucella zonaria* (Poda) (Dipt., Syrphidae) at Wimbledon. *The Entomologist* **79**:247.

Riley-Irving, J. E. C. 1947. Observations. *Bulletin of the Amateur Entomologists' Society* **7**: 83.

Stubbs, A. E. & Falk S. J. 2002. *British Hoverflies*. British Entomological & Natural History Society.

USEPA, 1992. *Cooling Our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing*. US Environmental Protection Agency, Washington.

Waller, G. 1946. *Volucella zonaria* (Poda) (Dipt., Syrphidae) in Kent. *Entomologist's Monthly Magazine* **81**: 58.

Woodcock, A. J. A. 1946. *Volucella zonaria* (Poda) (Dipt., Syrphidae) in East Kent. *Entomologist's Monthly Magazine* **81**: 57–58.

Woollatt, L. H. 1946. *Volucella zonaria* Poda and *V. inanis* L. (Dipt., Syrphidae) in Torquay, Devon. *Entomologist's Monthly Magazine* **82**: 72.

Wurzell, B. 1980. *Volucella zonaria* common in North-East London. *Bulletin of the Amateur Entomologists' Society* **39**: 69.